THE RAPTOR ACTIGRAM: A GENERAL ALPHANUMERIC NOTATION FOR RAPTOR FIELD DATA

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"I don't want to have pages and pages
of endless notes when we go home."

J.T. Harris (1979)

Abstract

Raptor actigrams are ethograms using an alphanumeric notation system that enhances the efficiency of observing, recording, and analyzing behavioral dta of individual birds. The actigram concept uses a small number of fixed elements, and a potentially large number of observer-specific subelements that permits maintenance of basic notations but generates high adaptability to different species and environments. Actigrams are therefore proposed for general use to promote comparative and quantitative field studies.

Introduction

In the rapidly developing area of raptor behavior progress has been hampered by significant inefficiencies encountered in recording, storage, access, transfer and quantitative analysis of data. The culprit is usually the familiar and indispensible notebook used by most observers during field and laboratory research.

Following is a technique that can substantially increase the overall efficiency of recording, using, and transferring data on raptor ecology and behavior. Departing from traditional procedures in ethology (where almost everyone designs his/her own ethogram code, etc.), this technique has been designed for general use. The two major reasons prompting this approach are (1) the unusual homogeneity found in the ecology and behavior of the *Falconiformes* and *Strigidae*; this opens up the potential for the development of an information management system that can be applied to all raptors and used by many researchers. And (2), we are standing at the threshold of interspecific and intergeneric comparative raptor studies (Walter 1979a): a general notation system would be an obvious advantage for this developing field.

The Actigram Concept

The need for higher efficiency and general applicability to a wide range of objectives, species, environments, and observers requires a work language that meets the following criteria:

(1) comprehensive but not too sophisticated,
(2) detailed and specific yet flexible,
(3) logical and easy to teach, learn and use,
(4) capable of recording and retrieving qualitative and quantitative data,
(5) time- and space-saving yet high in information content, and
(6) useful at different technological levels.

After several drafts and field tests by at least a dozen researchers a shorthand notation system of letters, numbers, and symbols has been developed that can be used to construct ethograms containing all recognizable "ethons" (Ellis 1979) exhibited by a raptor. Such ethograms are termed *raptor actigrams*; they serve to replace or supplement other written, verbal or mechanical records. The actigram notation achieves its general applicability by using a limited number of fixed behavioral *elements* (Table 1), and by offering an *unlimited* number of user-specific *subelements*. Data entries are ordered along a time gradient, and grouped into *segments* of uniform time length. The use of the actigram concept is not only time- and space-saving but promises to meet the other criteria listed above.

Table 1: Actigram Elements

	Individual Behavior		*Social Behavior*
P-Group	*Physical Status*	S-Group	*Sexual/Territorial Behavior*
P1	perched	S1	display from perch
P2	flying (beating wings)	S2	display in flight
P3	soaring, gliding	S3	other display
P4	other type of flight	S4	soliciting food
P5	climbing, hanging	S5	offering food
P6	hopping, walking	S6	copulation
P7	swimming	S7	physically harassing, attacking
P8	lying down	S8	defensive, evasive behavior
P9	other	S9	other
F-Group	*Feeding & Body Care*	N-Group	*Nest-Related Behavior*
F1	feeding self	N1	inspecting nest site
F2	drinking/bathing	N2	coll./carrying nest materials
F3	asleep	N3	building, repairing nest
F4	panting	N4	sitting on nest
F5	preening, cleaning	N5	serious incubation
F6	scratching	N6	turning, rolling eggs
F7	shaking feathers, sunning	N7	brooding, sheltering nest content
F8	pellet extraction/defecating	N8	feeding young
F9	other	N9	other
H-Group	*Hunting & Prey Handling*		*User-defined groups*
H1	prey search from air	A-Group	*Acoustic Behavior*
H2	other prey search behavior		
H3	prey chase, pursuit	X-Group	*Other Activities*
H4	prey capture, in possession of prey		
H5	prey transport	Y-Group	*Environmental Elements*
H6	prey transfer		
H7	prey handling	Z-Group	*Human Impact Elements*
H8	prey storage, "caching"		
H9	other		

The Notation System

A literature search for all behavioral characters or ethons resulted in a list containing well over 100 terms; many are closely related to each other while others are distinct but extremely rare in occurrence. In order to achieve a simple *and* comprehensive notation only 45 ethons were selected as actigram *elements*; each represents at least several behavior patterns, displays,

vocalizations, activities, etc. The elements are ordered into five groups (Table 1). The first three groups (P, F, and H) contain behavioral elements of raptors that can be observed year-round; the other two (S and N groups) are more often or always associated with reproductive seasons.

Each element appears in the actigram with its code composed of a capital letter and a single digit number (F4, P8, or N3). The ninth element in each group (i.e. P9, F9, H9, S9, and N9) is "open" (unspecified); it must be defined by the observer who needs an extra element in a particular group.

There are four additional groups listed in Table 1. Group A contains elements of acoustic communication, usually vocalizations. They remain unspecified here as there are too many vocalizations to permit a meaningful general definition of these elements. Group X is an entire unspecified group that may only be used if certain observed phenomena cannot be placed into any other group. Finally, group Y has been reserved for the listing of environmental "elements" (components of the bird's physical and biological environment), and group Z is comprised of human impact "elements" that we may wish to record.

Subelements do not appear in Tables 1 and 2 because they exist only *after* an observer has created and defined them. As an example, a falcon may use four perch sites near its nest site. We could simply write "P1" every time the falcon makes use of one of them. More accuracy can be achieved by creating four subelements of P1 (P11 =perch 1, P12 = perch 2, P13 = perch 3, and P14 = perch 4). Should there be more than 9 subelements per element, a third numerical digit (like P114 = perched on site no. 14) can be added.

Auxiliary symbols (Table 2) are a vital part of the actigram concept. They permit recording of action-response sequences, of simultaneously occurring ethons, and of accurate time data.

Table 2: Auxiliary Symbols

Symbol	*Definition*
	1. *Independent Symbols*
-	observed bird absent
!	bird present but not recorded
?	no data collected
/	end of time segment
+	repeat of last event
( )	inferred event(s), not directly observed or recorded
	2. *Element-dependent symbols*
	(To be used *after* the alphanumeric notation of element [and subelement]; followed by a numerical value)
*	duration in minutes within one time segment
.	("soaring for 3 minutes" — P3*3; "soliciting food for 15 seconds" — S4*0:15)
# or @	position of activity in an action-response sequence between individuals (male H4H5#1H6#3P2; female P1P2#2H5#4P2#5P1)
=	value or size (Y3 was user-defined as "air temperature in °C"; then Y3 = 27.5 means "air temp. 27.5°C.")
	3. *Interactive Symbols*
& or $	Simultaneous occurrence (P6&H4, F5&F7)

Observation time is divided into time *segments* of equal duration, determined by the observer (usually from one to ten min depending on research design and/or raptor activity levels). An example for a data sheet with six time segments reads:

P3P4P2P1F5/F5P2P3P1F5&6/P1P2-/-/P1F5/P1/

All segments *must* show a data entry (even if it should be +, −, !, ?). This encourages and maintains the observer's alertness and it generates data collections that can be quantitatively analyzed.

Preparation and Use of Actigrams

Nearly all imaginable situations can be recorded with the help of the alphanumeric codes; the observer must, however, possess a good command of the system. This requires some practice, preferably a field test and the transcribing of longhand notes into the actigram mode. Battery-operated "memoprinters" and electronic field recorders may also print or store the actigram notation (Stephenson & Roberts 1977, Morris & Shaw 1978, Dawkins 1971). Some can record an entire day's field work, then feed it directly into a computer for analysis. Programs for their quantitative and sequential analysis can be developed in different computer languages (BASIC, PASCAL, FORTRAN, etc.).

The actigram should never be regarded as the sole recording technique. Unexpected ethons may occur from time to time requiring an instant decision on the need for additional subelements; drawings need to be made of new postures or spatial features. Thus, pencil and paper, tape recorders, etc. and other field techniques (Nelson 1973) will always be needed during field work.

The definitions of subelements and other observer-specific coded information should be written down before or during the observation period. They should be placed in front of the observer at all times together with the actigram notation tables (Tables 1 and 2). Physical status elements are recorded only when they first occur. The change from flying to perched has to be P2P1 but if the bird then begins to preen we follow up with F5 (not P1&F5) as it is quite clear that the bird is perched while preening, and that it will remain perched until the codes P2,P3,P4, etc. indicate a change in physical status.

The final actigram should be preceded by a short paragraph containing the necessary introductory data on species, date, location, time segment, and observer-specified codes.

A relatively simple actigram is shown in Table 3; this is a transformation of Brown's (1980) written account of eagle activities.

A more complex actigram contains data on the Sooty Falcon (*Falco concolor*) during the nesting stage of the breeding season (Table 4), developed from many pages of notes taken in longhand (see also Walter 1981b).

Discussion

The selection of elements (Table 1) as well as alphanumeric notation may not be everybody's first choice. The guiding principles in the selection of elements were (1) their presence among most raptors, (2) the relative ease of recognizing these ethons in raptors, and (3) the need for descriptive, non-interpreting definitions. Because of the addition and subdivision potential of any actigram there should be few if any inconveniences in adhering to this structure.

The proposed notation itself was preferred over a part numeric or literary one. The latter two are more difficult to read and memorize than the proposed scheme. The reverse (a single digit number at the beginning of each element, the rest on letters) looks attractive as well but it seems more logical to have a group with nine elements where numbers 1-9 are right behind the capital letter.

The actigram has a built-in potential that can only be realized by the user. It offers a solution to a vexing problem: how to record and extract information in equally efficient ways. With the actigram there is no longer a need to glean information from dust-covered notebooks which often don't lend themselves to any quantitative analysis due to their anecdotal or incomplete nature.

In general, most raptor studies do not require the knowledge of exact minute and second for each ethon's occurrence; it is more important to record the context or behavioral sequence associated with a particular ethon, and to register the temporal distribution of peaks and lows in activity. This is accomplished with the use of uniform time segments; the duration of individual elements can also be recorded by using the auxiliary symbol * (see Table 2).

One reviewer felt that Table 1 might lead inexperienced observers to look with great determination for certain actigram elements, thereby overlooking other ethons, and perhaps misinterpreting certain behavior. This danger certainly exists with behavioral observations in general; the limited number of fixed elements tries, however, to avoid oversophistication and bias. On the other hand, I hope that Table 1 will contribute to the discovery of actually existing homologous and analogous ethons in different raptors.

The actigram concept should be of particular value for the behavioral studies of captive raptors (e.g. Wrege & Cade 1977), and in the long-term monitoring of a raptor pair's activities at the nest site. A full day's observations may fill only one or two pages of the finished actigram, reducing the otherwise unmanageable paper stack of longhand notes at the end of the season by a factor of 10 or more.

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Table 3. African Fish Eagle *(Haliaeetus vocifer)*

Breeding pair with downy eaglet, Lake Naivasha, Kenya, 5 October 1971

Observer: Leslie Brown

Time segments: 10 minutes each

Adapted and transformed from field data (Brown 1980: 140-144)

See also graphical analysis (Brown 1977: 70, Brown 1980: 49)

Subelements: P11 perched on nest, P111 standing in nest (eaglet visible), P12 perched near nest, P13 behind nest, P14 west of nest, P15 east of nest, P16 perched near Colobus Monkey, P17 perched on papyrus edge of lagoon, P31 soaring above nest, P32 soaring high above lake, P41 descends for attack; H11 hunting sortie over water, H2 prey search from shore perch; S71 attacking strange, intruding ad. female, S72 forcing strange female down near shore; A1 male's calls, A2 female's calls, A3 duetting; Y1 sunrise, Y5 calls from other eagles, Y6 several Colobus Monkeys in same tree, Y8 ad. eagle passing overhead; symbol = gives distance in meters from nest (P14 = 80) or distance flown (H1 = 200).

Table 3 continued on next page

Table 3 cont. . .

Time	Male
05:40	?*5 P16 Y5 / A1A1/
06:00	A1 Y5 A1 Y5 A3 / P16 S22 P12*6 P2P1=20 / + /
06:30	+*1 P2 H11*2 P1=30 Y1 P1=30*6 / P1=30 / +*7 P2 H1P1P2 P1-50 /
07:00	+ /+*6 P2=40 P12 Y6 A1 / P12 /
07:30	P2=20 P12 / P2P3P14=70*7 P2 P3&H1 P15=200/+*P2P14*=80*5P2P3&H1P14=80 /
08:00	+*4 P2 P14=30 H2 A1 + + +/ H2 / + /
08:30	+*2 P2 & H1 P13 / + / + /
09:00	P13 A1 P2 P11*3 A3 / + P2 P12 / P2 P14=80 /
09:30	+*5 P2 P15=40 /+ *7 Y5 A1 +++ P2P3 / + /
10:00	P32*8 P2#1Y5#2P31 / + / + *9 P41 S71#1 S72#3 P14=80 /
10:30	+ *5 P2 P14 P2 P11 / + / P2P13 A3 P2 P13=40 /
11:00	+ / + / P2 P32 A1#1 Y5#2 P32 /
11:30	+ *7 P2 P11 P2P1 / P2 P11 / + *4 P2 (P1) /
12:00	(P1)*3 P2 P13 / + / + *8 Y8#1 A1#2 /
12:30	P13 P2=30 (P13) A1 / (P13P2P13) A1 / (P13) P2 =#40 P13 /
13:00	+ A1 P13 / + / P2 P13 /
13:30	P13P2 (P2) H3 P2P12=30/P2(P2P12)A1 / (P12)*2 P2P1H2 /
14:00	H2 / + / + *8 P2 H3 P3 P1 /
14:30	P1 / + / + /
15:00	+/Y8#1A1#2P2H31H4P2P12P2P15#1 (F1#3) / + *2 P2P12 (H6) /
15:30	P2 P3 H1 P14=200 / P2 P12 / + *5 P2 P13 /
16:00	P13 / + / + *2 P2 P12=20 P2 P3 P16 /
16:30	+ / P2P1P2P3 H1=200 P2P14=80 H2 / + /
17:00	*H2**5 P2 H1&P3 P14=80 / + *8 P2 P3 P17*1 P2 (P1 H2) / - /
17:30	- / - / - /
18:00	- / P2 P3 *6 P13 / + /
Time	**Female**
05:40	? *5 P11 Y5 / A1 + /
06:00	+ Y5 A2 Y5 A3 / S22 P11 / + /
06:00	+ Y1 / P11 / + /
07:00	+ / + / + /
07:30	+ / + / + /
08:00	+ / + / + /
08:30	+ / + / + /
09:00	+ / + / + /
09:30	+ / + / + /
10:00	+ / + / + *9 P2 S71#2S72#3 P2#4 P11#5 /
10:30	P11 / + / + A3 P11 /

Table 3 continued on next page

Table 3 cont. . .

Time	Female
11:00	+ / + / + *5 P2 (P13) /
11:30	+ / + / + /
12:00	P13 / + / +*8 Y8#1 A2#2 /
12:30	P13 Y8#1 A3#2 / (P2P13) A3 + / (P13) /
13:00	(P13) / + / + *5 P2 P11 /
13:30	P11 / + / + /
14:00	+ / + / + /
14:30	+ / + / + /
15:00	+ / + *5 P111 A2 P2#2 P12 / P2 P12 A2 H4 F1 P2 (P1) /
15:30	(P1=300) A2 (F1) P2 (P1) / A2 P2P3P12P2P11 / + *5 N8 /
16:00	N8 *9 P11 / + / + /
16:30	+ / + / + /
17:00	+ / + / + /
17:30	P11*5 P111 / + / P2P3P1P2P1P2P3*3P2P11 /
18:00	+ / A2#2 / P11 /

Table 4: Sooty Falcon *(Falco concolor)*

Breeding pair near Hawar Island (Bahrain) with three young.

3 October 1977 from 5:00 - 7:30 and 15:45 - 18:00 from a boat anchored in front of the low breeding bluff. Shown here only period 06:00 ; 07:00 (local time).

Observer: H. Walter

Transformed from field notes and sketches. Five minutes per time segment. One line per time segment.

Subelements:

P11	perched at nest	A1	male's call on arrival with prey
P13	perched in full sunlight	A2	female's call of response to male
P14	perched in shade	A3	nestling's call when female flew by nest
P20	flying around nest site	A4	nestling's begging calls
P21	flying north	Y3	air temperature in the shade (°C.)
P24	flying southeast		

Table 4 continued on next page

Table 4 cont. . .

Time	Male	Female	Nestlings (3)
6:00	−*1P2#1A1#3H5#5#5H6#6P13	P2A2#2P2#4H5#7	P13
	P13	H7N8H7&N8P2P13	P13&F1
	P2H2*4:30	P13	F4
6:15	−(H2)	P13P2&P3	F4P13
	−P2*1	P2&P3	A3P13
	P24*4−P2&H5#1H6#4P21−H1	P24*2P20P2#3P13#5	P13A4#2A4#6
6:30	−(H1)	P13P2P13F1F5F1	A4
	−(H1)	P13P2&H5P13F1	P13
	−(H1)	P13&F1P2P11N8	P13F1
6:45	−(H1)	N8P2P1*1	F1P13
	−*3P2P1	P13	P13
	P13Y3−28.5	P13	P13*4P13&P14

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The ICBP World Working Group on Birds of Prey published its first Bulletin in February. This comprises 240 pages covering a wide range of current topics including population censuses, conservation programmes, problems of protection, international smuggling, reports of conferences, etc. from many different countries.

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